SPECIAL

Northrop News

ISSUE

NORTHROP
FLYING WING
XB35 BOMBER

NORTHROP NEWS · NORTHROP FIELD, HAWTHORNE, CALIFORNIA

THE FLYING WING BOMBER

The B-35 Has a Gross Weight of More Than 104 Tons

A giant Flying Wing, with an overload gross weight of more than 104 tons, has been completed at the Northrop Crenshaw plant in Hawthorne, California.

It has been in construction since early 1943, and was originally designed as a bombardment-type airplane of exceptionally long range and heavy load capacity. However, its design is such that it may now be adapted as a cargo plane.

The Army, which has wrapped this huge Northrop Flying Wing in secrecy, today permitted the following disclosures:

The Northrop Flying Wing is 172 feet in span, with an area of 4,000 square feet, and is capable of operating under overloading conditions at a gross weight of 209,000 pounds, more than 104 tons.

It is powered with four Pratt and Whitney Wasp Major engines, turning four, eight-bladed Hamilton Standard co-axial pusher propellers, and designed to deliver a total of 12,000 horsepower under military power.

The crew nacelle is pressurized.

This aircraft is the first of 15 such planes, identical in overall dimensions, which are to be produced and flown by Northrop under Army contracts. Cost for the first aircraft is estimated at about $13,000,000.

The Flying Wing, as its name implies, has no conventional fuselage or tail surfaces. It is shaped like a giant boomerang and carries its engines in submerged housings which do not protrude from the wing surface.

Control is achieved by means of "elevons", a Northrop development combining the functions of both elevators and ailerons. Normal crew for the XB-35, as the Wing is designated, is nine men: pilot, co-pilot, bombardier, navigator, engineer, radio operator and three gunners. Cabin space is available for six more men to alternate with crew members on long missions. Folding bunks accommodate the off-duty men.

Size of the XB-35 may be estimated from the fact that these 15 men are housed entirely within the wing itself. The only protuberances necessary are added to house the defensive armament.

ONE HUNDRED TONS

The XB-35s overload gross weight of 209,000 pounds (104½ tons) compares with a weight of 130,000 pounds (65 tons) for the B-29, the Army's heavyweight bomber of World War II.

The Flying Wing XB-35 is built with a new aluminum alloy developed by Alcoa which, tests have shown, is considerably stronger than previous materials of similar nature. The XB-35 carries gasoline in bulletproof, leakproof tanks, and can carry additional gallons in tanks in its bomb bays and other wing compartments.

The XB-35 is the latest step in a thoroughly-tested design, which dates as far back as 1923, when Jack Northrop first began experiments with Flying Wings. The XB-35 will be the latest of over a dozen tailless aircraft to be flown by Northrop Aircraft since the company was organized in its present site at Hawthorne, Calif., in 1939.

The wing section itself is 37½ feet long at the center, tapering to slightly more than nine feet at its tips. It sweeps back from center to tips, making the overall length of the ship slightly more than 53 feet. It stands over 20 feet high when at rest on its tricycle landing gear, which is equipped with five-foot six-inch dual wheels on the main gear and a four-foot eight-inch wheel on the nose gear.

When the sky giant is rolled out on the Northrop flight strip it is expected to weigh in at 89,000 pounds. Its design useful load is 73,000 pounds, and could reach as much as 120,000 pounds.

The Flying Wing design is not new. In 1923 Northrop drew first plans for such a plane, which he believed would eliminate the drag-producing fuselage, tail assembly and engine nacelles, and make the entire aircraft a working surface.

His solution was to put everything into the wings —passengers, engines, cargo and fuel. That was too radical—for the 1920s.

John K. Northrop

In 1928, at a small plant in Burbank, Calif., Northrop built the first Flying Wing, which wasn't—strictly speaking—a true Flying Wing. It had a tail surface mounted on twin tubular booms behind the wing. But the pilot, engines and retractable landing gear were all inside the wing during flight, and the ship flew successfully through 1929 and 1930.

In 1939, when the present Northrop Aircraft, Inc., was organized, the same pioneering tradition was revived. The staff of designers set up the first true Flying Wing. Two small 65-horsepower engines powered the craft, which was 38 feet in span by 17 feet long. A model was sent to Langley Field for testing in the National Advisory Committee for Aeronautics' wind tunnel.

The first little Flying Wing, designated the N1M, made over 200 successful flights, helped to prove the Flying Wing theory, and then was retired to the aviation museum at Wright Field, Ohio.

N1M TEST FLIGHT

From the time the N1M first flew in 1940, Northrop engineers began to think of it in military terms, and preliminary studies of various sizes and arrangements were made, Assistant Secretary of War Robert Lovett, General H. H. Arnold, Maj. Gen. Oliver P. Echols, and others visited the Northrop plant in 1941 and were shown motion pictures of the N1M in flight. They suggested that Northrop submit designs.

Three weeks later, in September, 1941, the preliminary designs were submitted to ATSC engineers at Wright Field, to meet the specifications set by the Army Air Forces. This design provided for extremely long range, high speed, and high altitude performance with a pressure cabin for the crew and a huge bomb load.

Warren Knieriem was named project engineer. Other executive engineers closely associated in the project were W. J. Cerny, director of engineering, Dr. W. R. Sears, chief of aerodynamics, and A. M. Schwartz, chief of structures.

WRIGHT FIELD APPROVAL

On July 5, 1942, the Mockup Board from Wright Field inspected a mockup of the full-size crew nacelle and a portion of the left wing, and gave it official approval.

Northrop's engineering staff was heavily engaged in other work, including production of the Black Widow P-61 night fighter, so engineering aid was obtained from the Glenn L. Martin Co. of Baltimore, Md.

Northrop engineers took charge of aerodynamic research, basic stress work, landing gear, controls and control surfaces, equipment, electrical and radio installations and armament. The Martin group, which recently completed its portion of the project, was charged with design of the wing structure and power plant installation.

Complete co-ordination was necessary. Northrop was in continuous communication with the ATSC at Wright Field, and Martin at Baltimore. The teletype wire was open from 5 a. m. to 5 p. m. daily as the two engineering groups and the supervisory officers at Dayton labored to dovetail their giant project.

The Crenshaw bomber plant, at the east end of Northrop Field was completed in January, 1943, and the fabrication of parts for the XB-35 began at once. The four-engined ship represented an operation of major size and, to provide flight research data, four 60-foot scale models were built. These were flight tested over a three-year period at Muroc Army Air Base, Calif., during which time the XB-35 was taking shape.

The XB-35 Flying Wing must be first flown from Northrop Field, since there is no way to disassemble it into sizes which could be transported by any known means to Muroc, the AAF base, for tests.

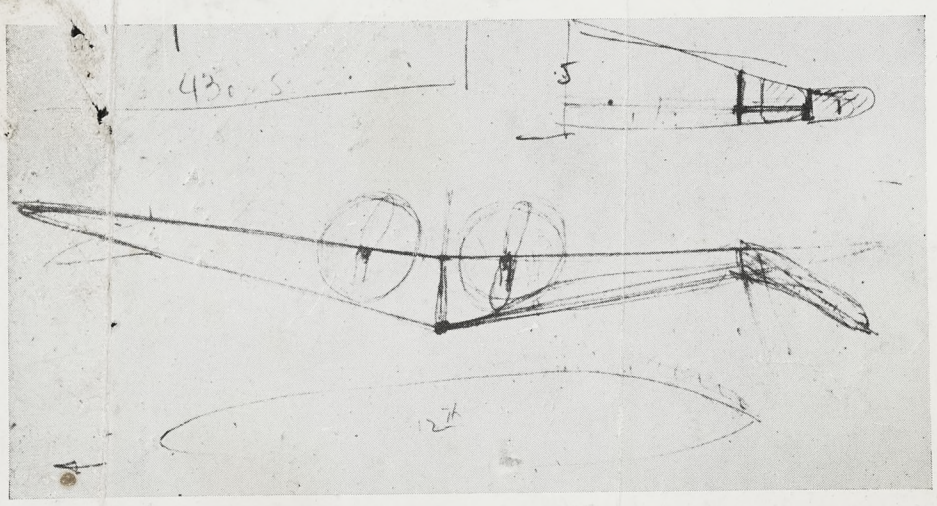
Control of such a large airplane, particularly at the high speeds of which the XB-35 is capable, posed a problem to the designers.

Unassisted, the pilot could not move the controls of the XB-35, even at cruising speed. A full boost hydraulic system was installed and then coupled with a Northrop-designed "feel" system, which puts automatic pneumatic loads on the controls.

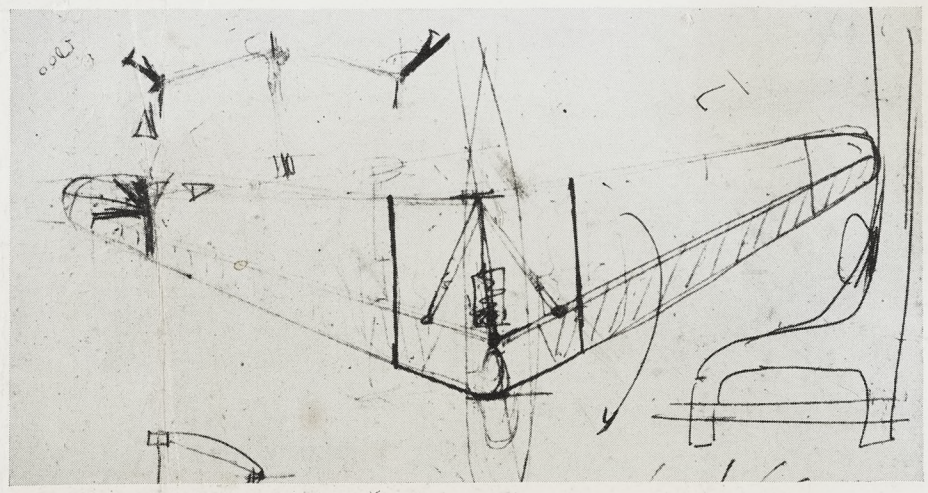
Without the "feel" system the pilot could move his booster controls sufficiently with two fingers to tear off the control surfaces. The "feel" applies pneumatic forces to the control system, varying at different speeds, to hold control movement within the limits of safety.

Although designed for a bomber, the XB-35 easily could be adapted as a cargo liner, according to LaMotte T. Cohû, general manager and chairman of Northrop Aircraft's board.

As a cargo transport, Northrop engineers believe, the true aerodynamic efficiency of the Flying Wing can be proved in savings of fuel and time over trips of any distance.

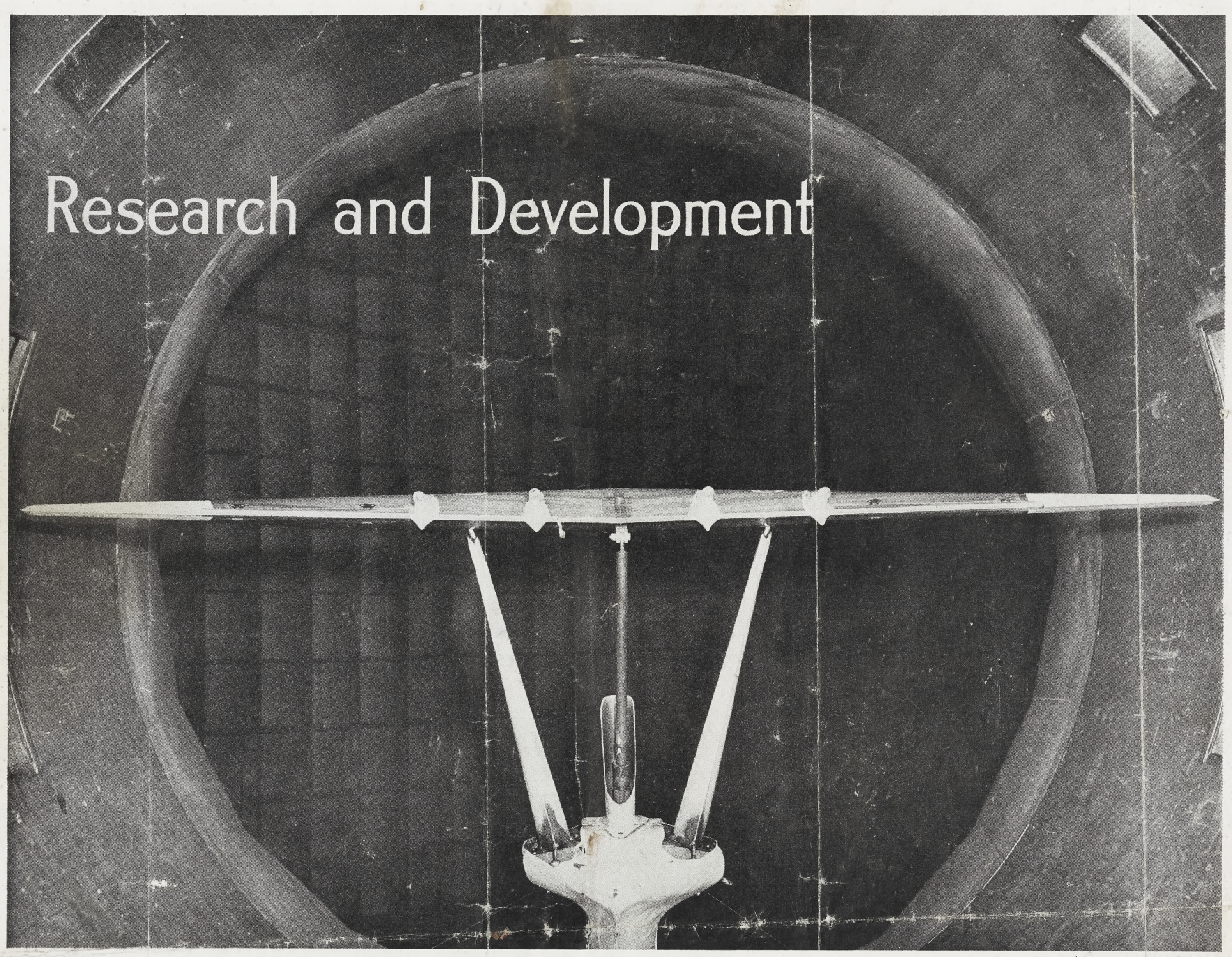


SKETCHES DRAWN by Jack Northrop during first Flying Wing engineering conference illustrate original concept of all-wing tailless airplane.

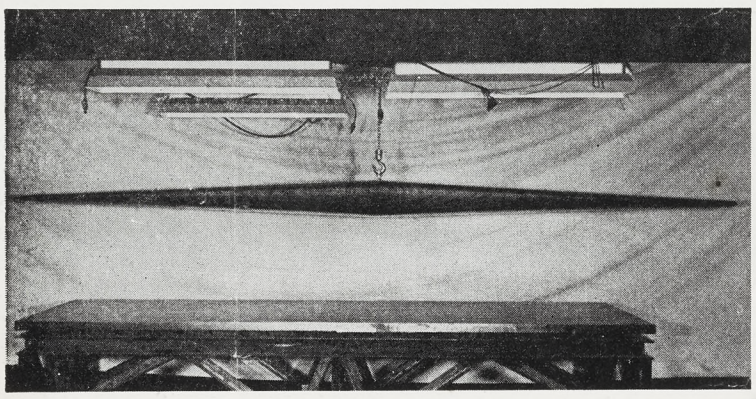


Early models were designed with drooped wing tips. Sketches were salvaged for history after meeting by Walter Cerny, director of Engineering.

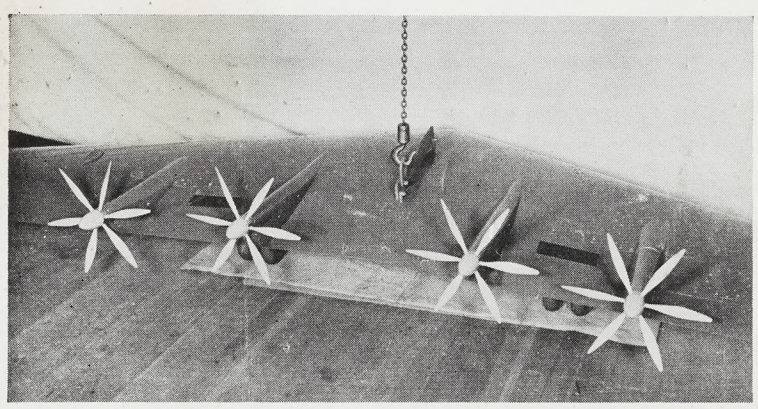
Research and Development



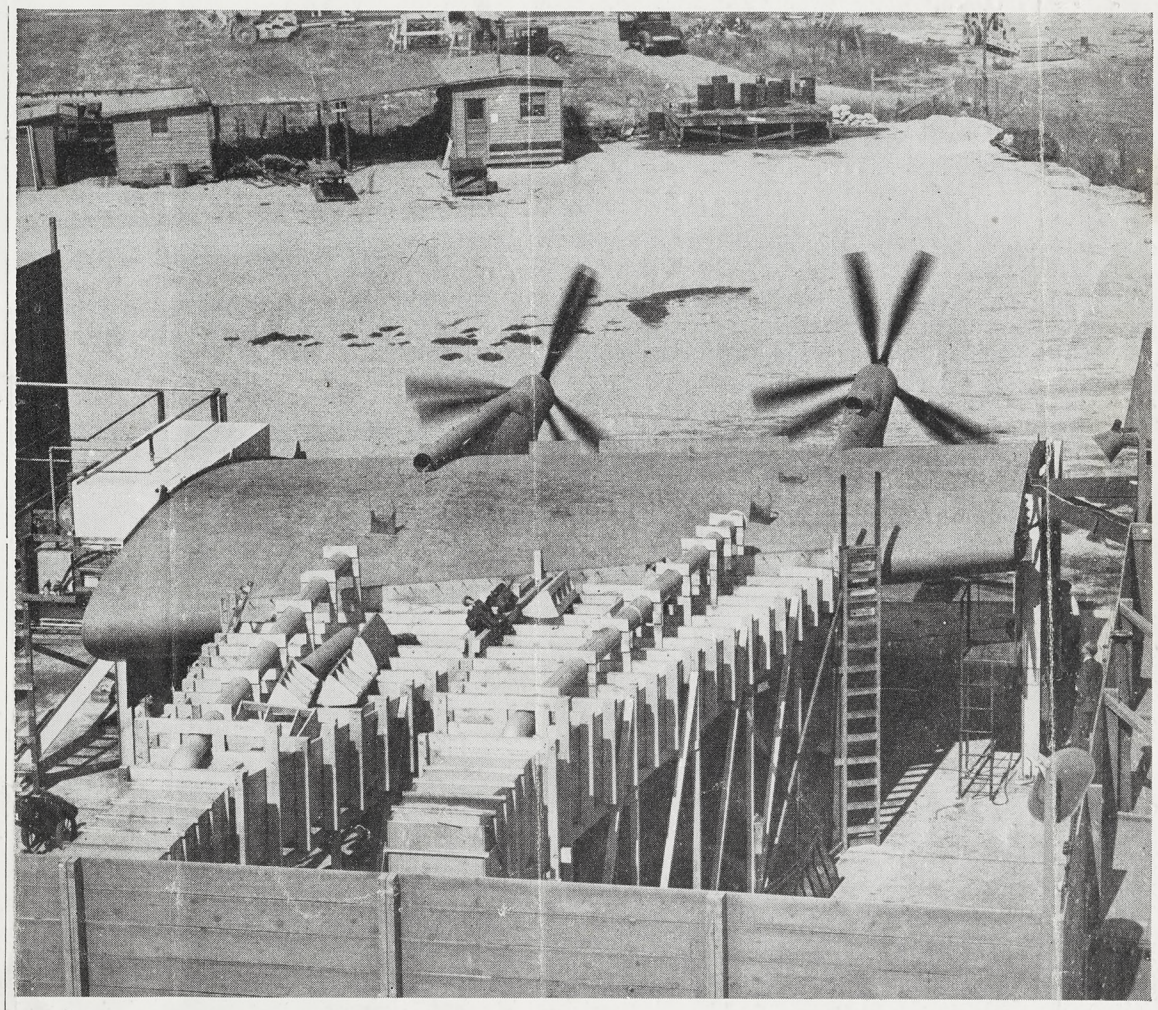
SCALE MODEL OF THE NORTHROP FLYING WING XB-35 MOUNTED IN THE BIG NORTHROP WIND TUNNEL. THOUSANDS OF HOURS OF TESTING PROVED TO DESIGNERS CORRECTNESS OF BASIC ALL-WING DESIGN.



Like nearly every "first airplane," the big bomber was initially reproduced in wood. This wind tunnel model head-on-view illustrates how "clean" the Flying Wing looks with armament removed.



SEVERAL PROPELLER combinations were tried on the big Flying Wing's 16-foot scale model. This was one design tested which consisted of six-bladed counter-rotating propellers. These were later replaced with eight-bladed propellers.



NORTHROP FLYING WING TEST STAND. Above you see the largest power plant installation test stand in the world. Built to test the installations for the XB-35 on the four Pratt & Whitney Major engines, the recording instruments required over 12 miles of temperature sensitive wiring and pressure transmission tubing. Test runs on big motors sometimes continued as long as five hours with crew in constant attention.

The "Why" of the XB-35 Flying Wing Bomber

Northrop's Flying Wing is the closest approach yet made to an airplane consisting only of a pure supporting surface—a plane in which every exposed portion contributes to lift in return for the drag it causes.

It is one of a new "family" of airplanes. Jack Northrop has said that he hopes eventually to demonstrate air transport planes of all-wing design with top speeds as much as 100 miles an hour greater than would be possible with conventional designs of the same power and capacity.

"It is not too much to say that this new family of airplanes, adaptable to almost all types of military and civil aircraft, will have a profound influence on all airplane designs and on accepted performance standards," he declared.

Here are the reasons for the Flying Wing's tremendous practical value.

Air is substantiaal stuff. As it passes over the surface of an aircraft in flight it drags constantly at the plane, holding it back. This drag costs horsepower.

Lift, the raising force on the wings of an airplane, enables it to fly. The more lift an aircraft has, the better able it is to carry heavy loads. Thus designers always have sought to obtain more lift and less drag.

On a conventional airplane, only the wing contributes lift in return for the drag it causes. The fuselage, engine nacelles, tail surfaces and all other extraneous parts create drag, and contribute only in rare instances and in small degree to lift. They are the evils which designers of conventional planes, have considered necessary.

On the Flying Wing, virtually all exposed parts of the aircraft are the wing itself, and thus create lift. This increased lift makes possible greater loads. Meanwhile drag is decreased by the elimination of the fuselage, tail surfaces and exposed engine nacelles. Longer range and greater speed is the result.

Northrop has flown 12 tailless aircraft since the present company was formed in 1939. Northrop engineers have learned much from these experimental models, and have made further studies with wind tunnel tests. Data gleaned in these experiments indicate from 50 to 100 per cent greater efficiency (based on the ratio of maximum lift to minimum drag) for the Flying Wing.

LOW DRAG—HIGH LIFT

Walter J. Cerny, director of engineering, believes the advantages of the Flying Wing can be classified in five ways:

(1) The low-drag, high-lift feature, which means that in practice the Flying Wing can transport any weight faster, farther and cheaper than can an airplane of conventional design.

(2) The simplicity of construction of the Flying Wing. It presents few structural complications and costs less to build, since it is a single unit, in which the structure extends through from tip to tip with no added tail or fuselage to build.

(3) The advantage of a better distribution of weight. Compartments all along the span can carry cargo and distribute the weight more evenly over the wing surface which supports it. This eliminates the need for excessive "beefing up," such as is necessary in conventional planes where the weight is concentrated in the fuselage, and must be distributed over the wing from this point by heavy structural members.

(4) For cargo purposes, the ease of loading and unloading. Cargo can be placed in span-wise compartments, where any part of the plane's load is easily accessible through its own cargo door. This eliminates moving the cargo about for loading and unloading.

(5) For military purposes, the Flying Wing presents a smaller target while engaged either in offensive or defensive maneuvers.

Comparison between the Flying Wing and the conventional aircraft is best illustrated by performance figures obtained from Northrop patent applications and backed by three years of tests in which planes identical in scale to Northrop's XB-35 were used.

If two airplanes, one a Flying Wing and the other conventional, are built for the same purpose with identical power, gross weight and fuel load, the Flying Wing will:

(1) Carry one-fourth more useful load in the form of passengers, cargo or fuel.

(2) Travel one-fourth farther with an identical fuel load.

(3) Transport 25 per cent more load over a given distance on a given amount of fuel.

(4) Travel substantially faster with the same "thrust" or applied horsepower.

THIRTY PER CENT FASTER

Engineers believe the XB-35 to be at least 30 per cent faster than a conventional craft of the same load and horsepower, but the greatest advantages gained are in range, load and economy.

One of the simplest methods of judging relative merits of aircraft designs is by the comparison of maximum lift, which is desired, to drag, which must be kept at the minimum possible.

This ratio for the best commercial transports or bombers is in the order of 90 to 100 to one. This means that if a conventional plane has a maximum lifting capacity of 100,000 pounds, it will have a minimum drag of at least 1000 pounds, which must be overcome by the engines.

On the Flying Wing the ratio is estimated between 140 and 200. Thus a Flying Wing with a drag of 1000 pounds would have a lifting capacity of 140,000 to 200,000 pounds, as compared to the 100,000 pounds of the conventional plane.

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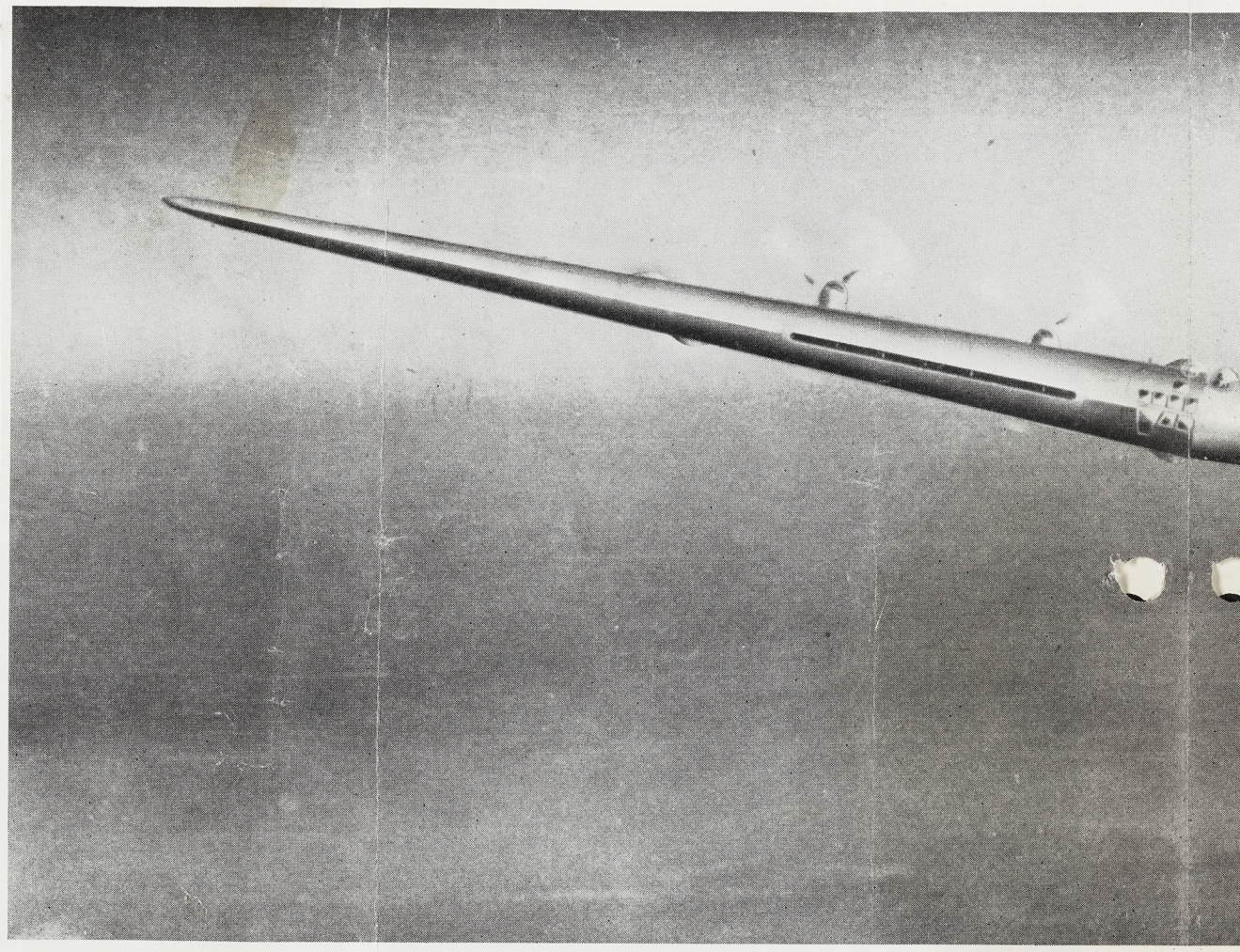
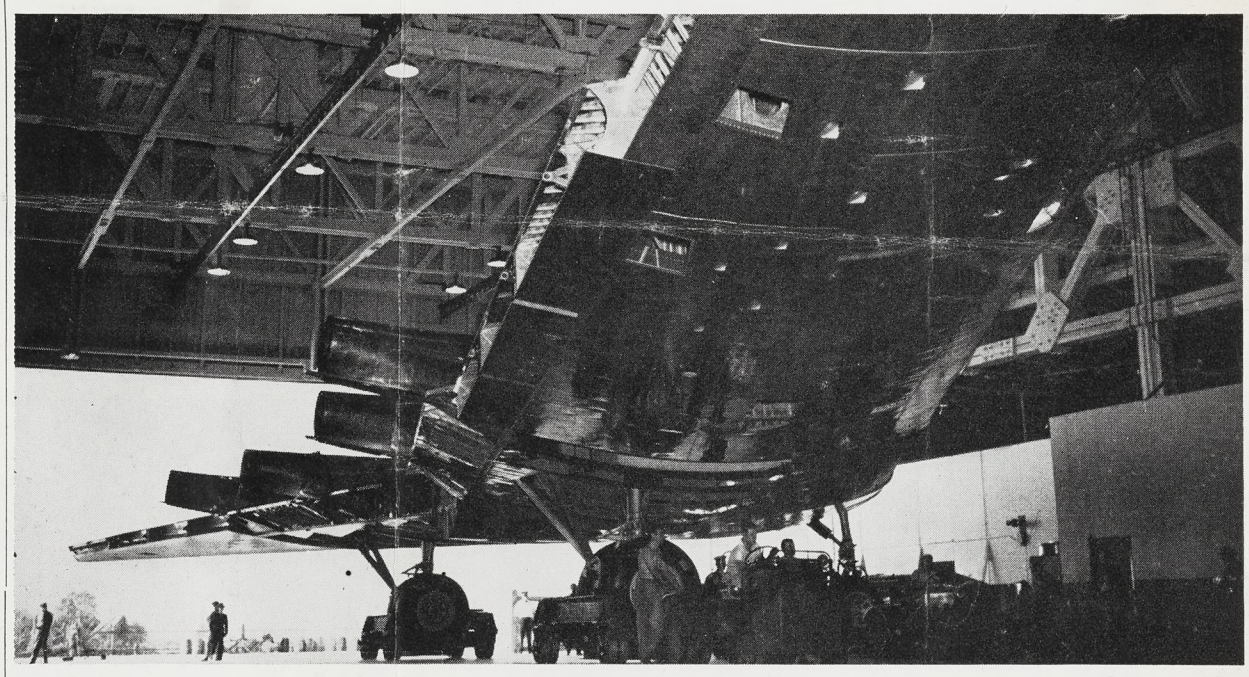


NORTHROP ARTISTS SHOW US JUST HOW THE FLYING WING BOMBER WOULD LOO

THE XB-35 DWARFS



"SWEEPBACK" of the big Flying Wing bomber can be seen in this foreshortened view, taken near the right wing tip. The tricycle landing gear, mounting five giant tires, is also visible.

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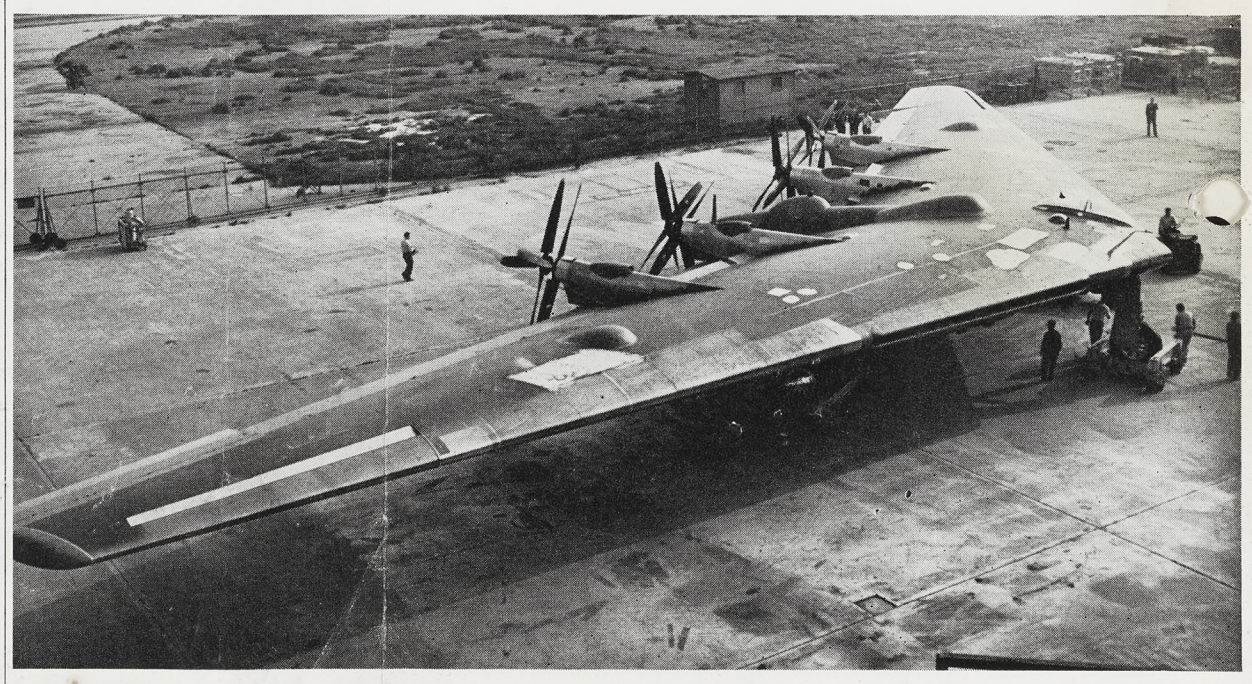

THIS VIEW shows plainly where co-axial pusher propellers are mounted. Four engines of 3,000 horsepower each are buried in the wing. This is a side view of the completed plane.

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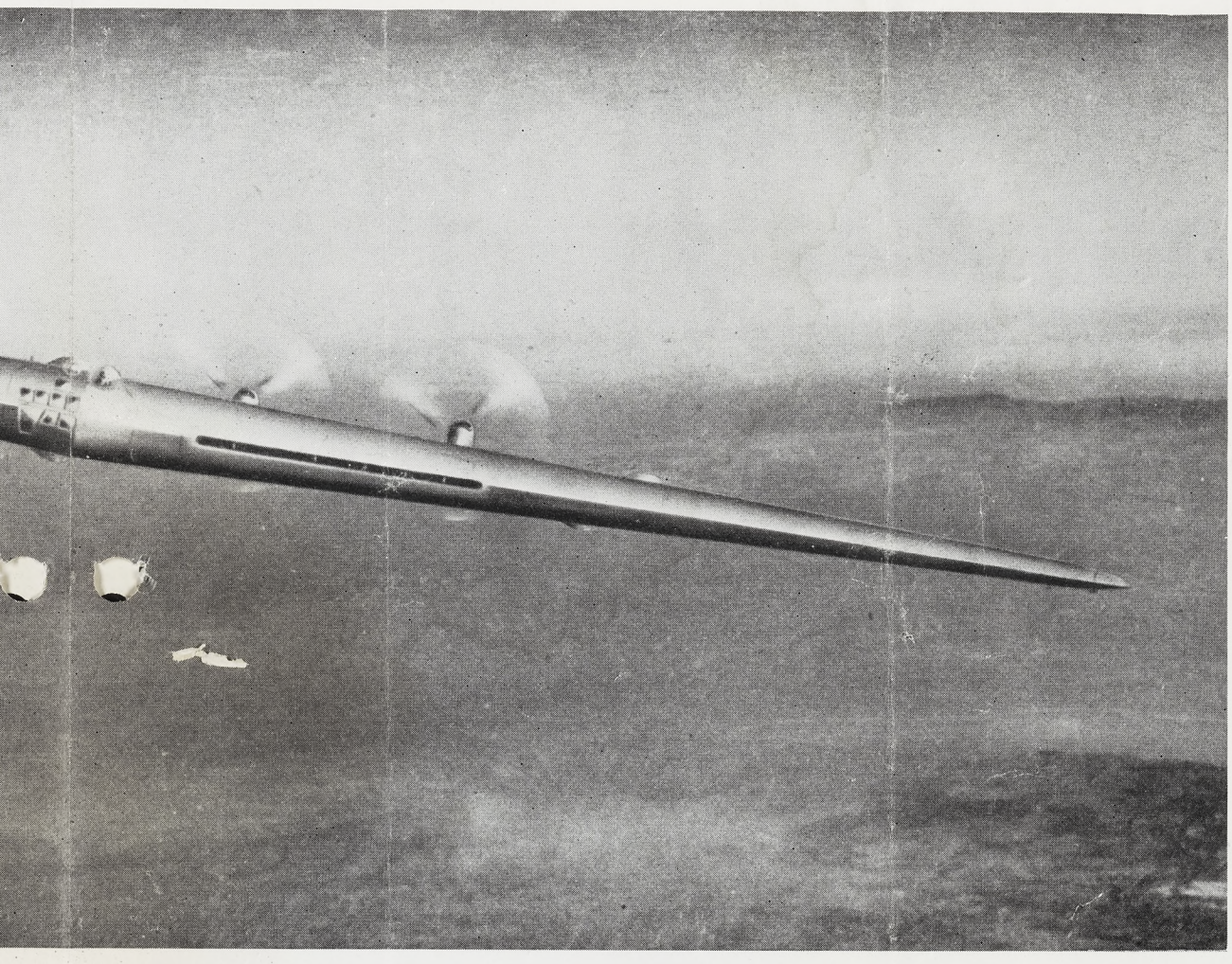
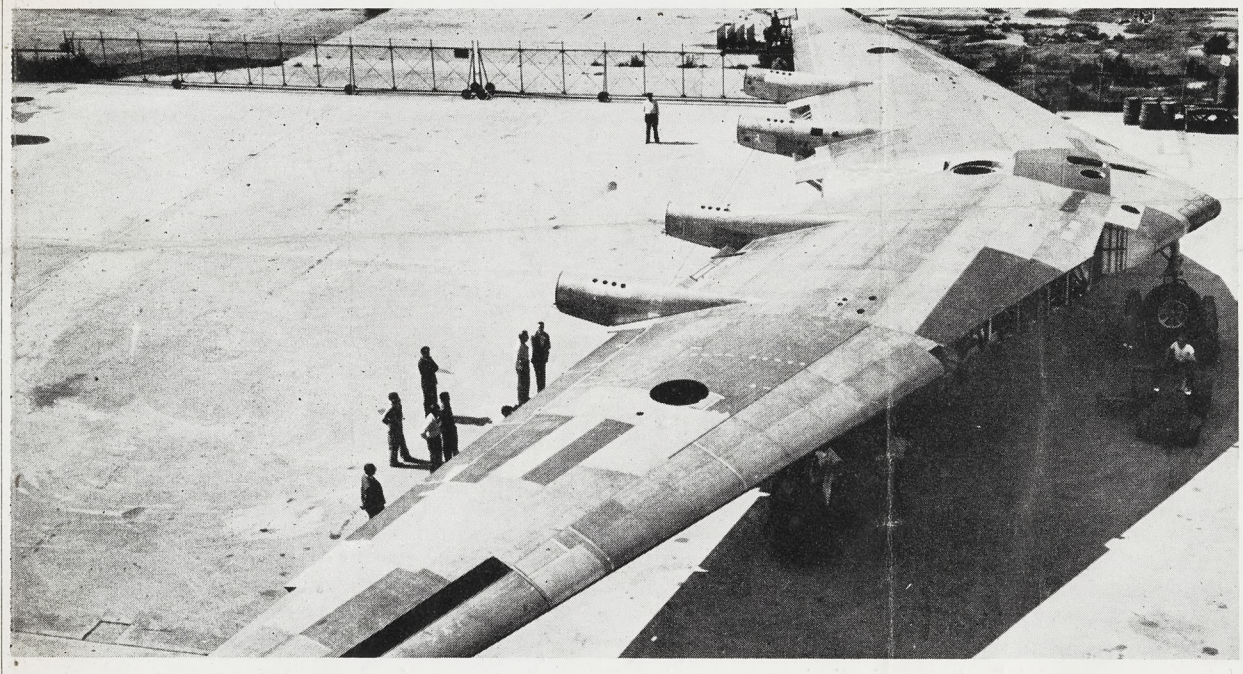


ULD LOOK TO AN AIR ENEMY—KNIFE-LIKE LEADING EDGE PRESENTS DIFFICULT TARGET.

FS FLIGHT APRONS



SHAPE AND SIZE of the bomber are easily seen in this photo of a partially completed airplane on the apron of Northrop Field. Propeller mounts protrude from the trailing edge of the wing.

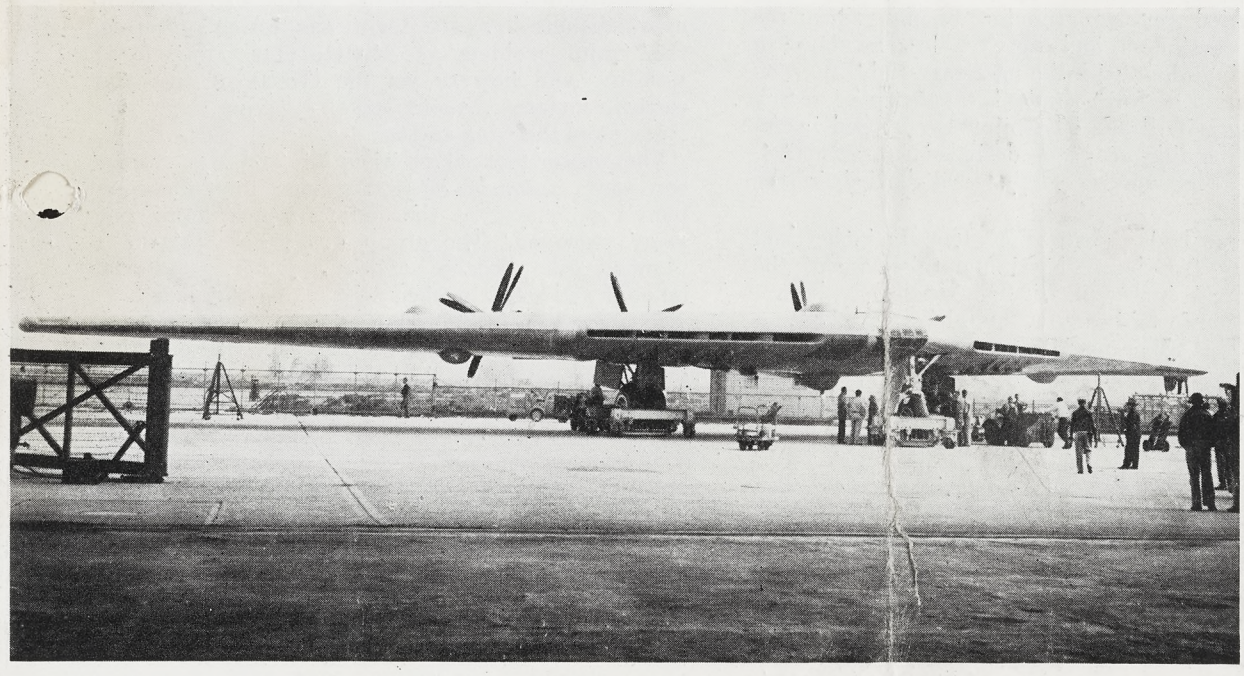


PHOTO shows the full span of the completed Flying Wing bomber—172 feet from tip to tip. Bomber's design also lends itself to long rang e military and commercial use.

Northrop Design -- the First True "Flying Wing"

If the XB-35s are as successful as expected, they will be so superior to existing equipment that the Flying Wing may force radical changes in military aircraft designs. This in turn would hasten development of commercial airliners built on the Flying Wing principle.

In the early stages of the Flying Wing development, control of the Flying Wing was one of the problems that required solution. The first versions had flight characteristics somewhat different from those of a conventional plane, because of the elimination of the fuselage and tail surfaces. Much work has been done to make the Flying Wing fly exactly like a conventional plane, and "feel" like a conventional plane to the pilot, with the result that late models have been no more difficult to fly than standard aircraft.

"We never had a Flying Wing that wasn't a flyable airplane," declared Mr. Northrop. "None of them had characteristics considered excessively dangerous, or which rendered the airplane seriously unstable."

"JEEP" STARTED THE PARADE

The first of the true Northrop Flying Wings, called the "Jeep", made its initial flight in 1940. Hundreds of flights made with this plane, named the N1M, proved it to be completely normal in stability and control. This demonstration was further supported by a series of other such Flying Wings, the N9Ms, which were operated in rough weather without difficulty. Thus the safety of the Flying Wing has been successfully proved.

It is believed that the Flying Wing has a tremendous future as a transport, and that its proved efficiency over conventional models will make the latter obsolete in time.

For many years Northrop lived in "continual dread" of someone else developing a flying wing, because it seemed so logical and obvious that aircraft design would proceed along such lines.

Other designers have tried. Burgess Dunn constructed a tailless biplane which flew around 1917. Lippisch in Germany and Hill in England produced their own versions of the idea. But all previous designers have used vertical tail surfaces or exposed engine nacelles or short fuselages or other drag-producing elements.

In 1939 and 1940 the Germans were known to be experimenting with gliders similar in configuration to the Flying Wing. After the occupation, U. S. troops captured Dr. Rudolph Goethert, who had developed a flying wing design known as the Gotha P60. A comprehensive report submitted to Wright Field indicated that the quality of design and the caliber of the designer both were very high.

In Germany, the Horten brothers had built a flying wing sailplane in 1934, and had studied the potential of the flying wing design extensively. The Nazi government, however, did not believe in the future of this radical departure from conventional aircraft, so the Horten brothers were not allowed capital to proceed.

THE GERMANS TRIED

Then the Germans got wind of the Northrop N1M. They immediately granted the Horten brothers capital and facilities to develop their version of the flying wing.

The Horten sailplanes consisted originally of a thick wing of triangular shape with a thickened central portion for the pilot. Ailerons and elevators formed separate parts of the trailing edge, and directional control was effected by airbrakes on the surfaces of the wing.

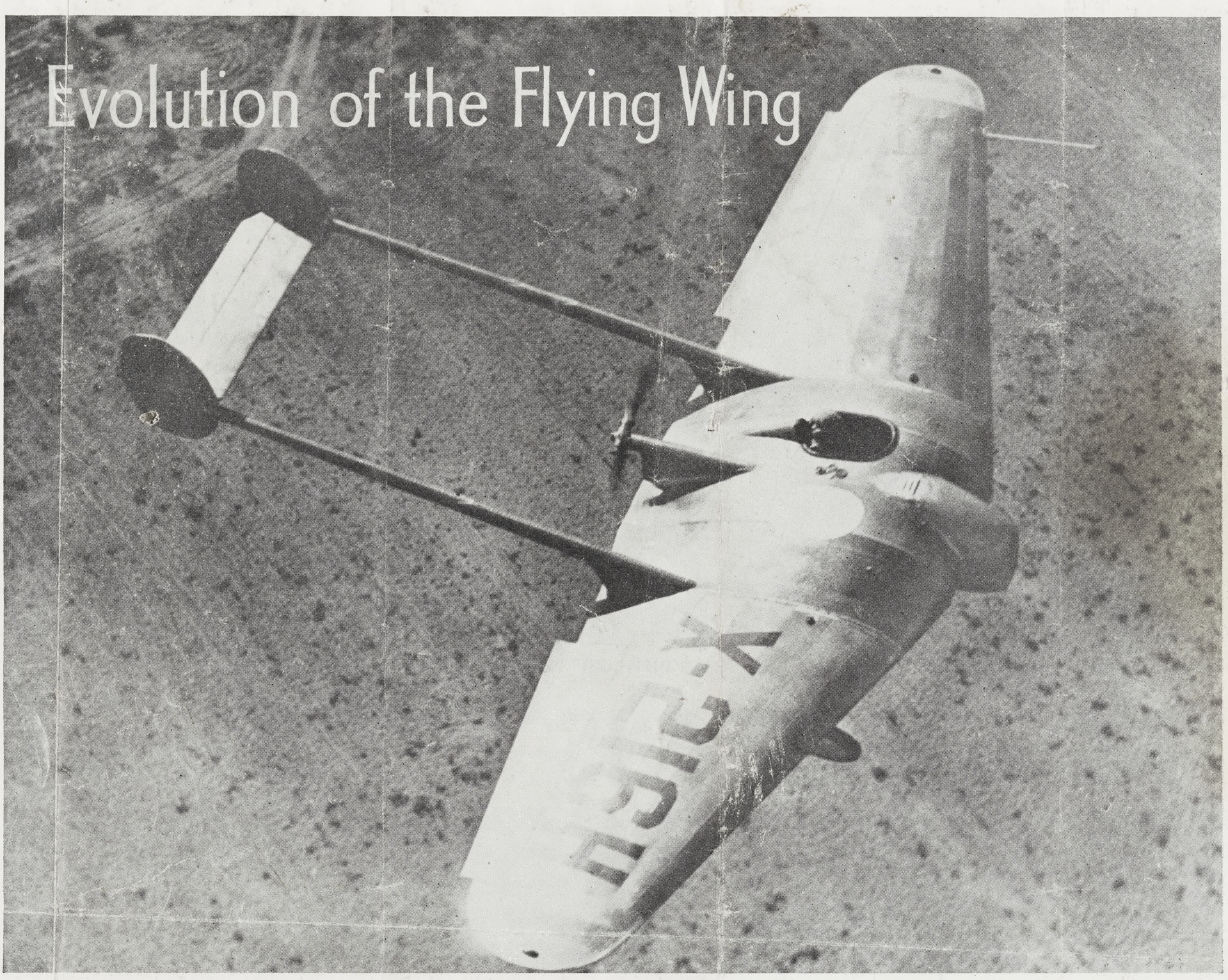
Light Horten flying wing planes, with power, were built, and it was claimed that a corresponding conventional low-wing monoplane equipped with the same engine and carrying the same load, had a top speed 39 per cent lower than their wing, a strong testimony to the advantages of the low-drag tailless airplane.

A more powerful Horten flying wing which was experimented with extensively during the war was a twin-engined tug for towing gliders and sailplanes. This aircraft had swept-back, tapered wings, with a span of 52½ feet. The two engines were buried in the wings and drove pusher propellers by means of long shafts. It is not known how satisfactory the experiments with this aircraft were.

Horten flying wing gliders demonstrated great efficiency. One, with a span of 66 feet and a wing area of 390 feet, was dived at 290 miles an hour, and was claimed to be spin-proof. It reached an alitude of 17,000 feet during a soaring competition.

Other flying wing gliders designed by the Horten brothers made cross-country flights of more than 180 miles and thermal climbs to more than 21,000 feet, circling through clouds and, in some cases, encountering icing conditions, according to Aircraft Engineering (Jan. 1945).

But, so far as is known, the Northrop design is the first which can be termed a true "Flying Wing", with control surfaces directly incorporated in the wing. It is apparent that the public and even aircraft manufacturers have failed to recognize the potential advantages of this new and revolutionary type of aircraft.



THE FIRST NORTHROP FLYING WING IS SHOWN HERE ON ITS MAIDEN FLIGHT — WING SPAN WAS 30 FEET SIX INCHES.

MAN'S DREAMS BECOME FULL REALITY

Since man first learned that mechanical wings would carry him into the sky, designers have dreamed of the ideal airplane—one of maximum efficiency in which every exposed part would have a useful purpose, contributing to the lift of the flying machine.

John K. Northrop and the men who have been associated with him in the aircraft business during a quarter of a century turned this dream into a reality.

The reality is the Flying Wing.

In 1923, Northrop first conceived the nucleus of an idea which was far ahead of its time. Like other such ideas, it was first met with skepticism, and a dread of "radical" advancement.

The idea was that of an airplane which would consist only of a pure supporting surface. This supporting surface would have no fuselage, tail surfaces or other extraneous parts which would contribute to drag without producing lift. Therefore, he reasoned, it must be an all-wing airplane.

By eliminating the parasite drag of conventional airplanes, Northrop reasoned, the all-wing design would enable an engine of given horsepower to propel a given load farther and faster. Weight of parasite parts could be replaced with payload. Greater economy and range would result.

Information on airfoils suitable for such a project was hard to obtain, since the science of aircraft design was in its infancy in 1923. But Northrop and a friend, Anthony Stadlmas, began making calculations and drawings. They started to build an all-wing glider. But both men were short of money and the project was abandoned.

And well it should have been, they were told many times. A Flying Wing was too "radical."

So the theory of the all-wing airplane was filed in a mental pigeonhole for five more years, while Northrop worked on more commonplace airplane designs. Finally in 1928, he and W. K. Jay formed the Avion Corporation at Burbank, California, and his first real opportunity arose.

His first effort was not actually an all-wing airplane. But it was a step on the way.

"We didn't dare go the whole way and eliminate the tail," he said.

FIRST LONG STEP

But the fuselage was eliminated. Tail surfaces were carried on two tubular booms, since the Northrop designers had not yet learned how to build a wing alone with the necessary stability. The simplification of form resulted in substantial reduction of parasite drag. The pilot was housed in the wing, the landing gear was designed for retraction, and the 90-horsepower engine was buried in the wing.

The plane had a span of 30 feet six inches and was twenty feet long. Maximum thickness of the wing was 34 inches, a bit too shallow to house the pilot comfortably, so a "bubble" was added on the top. This plane made many flights in 1929 and 1930 and afforded invaluable research data. Then financial conditions became stringent in the early 1930's, and the Flying Wing was set aside again for development of more conventional types.

In 1939, the present Northrop Aircraft, Inc., was formed, and as its president, Mr. Northrop was able once more to pursue his experiments on an all-wing airplane.

With his engineering staff, he started work in August 1939, on the first of the true Flying Wing designs, a completely tailless aircraft which contained all the controls and stability necessary for safe operation.

W. J. Cerny, an astute designer who had been associated with Northrop since 1928, was supervisor of the project. From the California Institute of Technology, Northrop recruited the consulting assistance of Dr. Theodore von Karman, director of the Daniel Guggenheim School of Aeronautics, and Dr. William R. Sears, von Karman's assistant, who now is Northrop Aircraft's chief of aerodynamics.

TOTALLY UNLIKE THE BIRD

The first Flying Wing was the NIM. It was built in the wooden mockup form, which made possible many changes in shape during the testing processes. One major problem was how to obtain directional stability, and how to get the effects of fins and vertical surfaces without actually having them protrude from the wing surface.

The answer took shape when Mr. and Mrs. Northrop were guests of Moye Stephens, then the company's secretary, at the latter's ranch home one rainy week-end. The group was unable to take a planned hike because of the weather, so stayed indoors and experimented with paper airplanes.

These paper models at first were in the conventional schoolboy's pattern, but later were folded into shape much like that of the Flying Wing. Tips of the wings were bent up and down and with each change the paper planes were "flown". Soon it was found that a downward bend of 35 degrees gave the best performance. The tailless variety, incidentally, flew far better than the conventional type. This seeming child's play actually resulted in valuable data and, later at the plant, was put into practice.

Wind tunnel and flight tests were carried out, and the desired effect was obtained by the drooped tips. So the NIM was built on that pattern and models were constructed for testing. They were flown successfully in the National Advisory Committee for

Army Air Forces Help Write Flying Wing History ---

Aeronautics wind tunnel.

Previous to the tunnel tests, the N1M had been taken to the Muroc Army Air Base, where Test Pilot Vance Breese began experimental runs. The first flight was actually an accident. While taxiing at high speed, the N1M struck a rough spot in the lake bed.

It bounced eight or ten feet into the air and made a good flight of several hundred yards, while its designers watched with their hearts in their throats. The N1M landed safe and sound. The hearts retreated; a great aviation incident had occurred.

Moye Stephens took over flying the N1M, and more than 200 successful flights were made before the N1M went to the Army's aviation museum at Wright Field.

WING TIP BECOMES STRAIGHT

Lack of power handicapped this first model. Two 65-horsepower Lycoming engines were used at first and later exchanged for two 120-horsepower Franklin engines, which improved the performance. Span of the N1M was 38 feet; length seventeen feet. It had 300 square feet of area; the wing-chord tapered from 168 inches at the center to 24 inches at the tip; maximum thickness of the wing was 36 inches.

As the development of this airplane progressed, it was found that straight wing tips could be substituted for the drooped ones without loss of stability. This was done, and the resulting configuration is virtually the same as that of the giant XB-35.

It was in September, 1941, following a visit by Assistant Secretary of War Robert Lovett, and Major General Oliver P. Echols, that preliminary designs were submitted for the XB-35 to Army Air Forces engineers at Wright Field. After study and evaluation of the design, Army officials were satisfied that it offered promise of unusual performance, and awarded a contract for the huge bomber.

But that simple statement doesn't begin to tell the story.

There would have been no XB-35 but for the enthusiasm and farsightedness of men like General H. H. "Hap" Arnold, Mr. Lovett, General Echols, and many other Army Air Forces engineers and technicians.

WRIGHT FIELD AND WASHINGTON

The company was given valuable aid and encouraged along the way by the practical and progressive men forming Wright Field's Engineering Division; Armament Laboratory; Radio and Radar Laboratory; Equipment Laboratory; Power Plant Section and other groups in this great technical and procurement organization. The project was guided from Washington by personnel of the Maintenance, Materiel and Distribution Division, Headquarters, AAF.

Too much credit cannot be given to the AAF for its help in this project. Lack of space prevents a list of the many individuals who have made substantial contribution to the development of the gigantic Northrop Flying Wing XB-35 bomber.

Designing began in early 1942. Several wind tunnel models in eight-and sixteen-foot sizes were built for testing in the Northrop wind tunnel and at the Langley and Moffett Field tunnels of the NACA.

Northrop engineers were designing the Flying Wing as a long-range bomber, with increased speed and with a high-altitude pressure cabin for the crew. It must fly extremely long ranges without stopping, and carry a huge bomb load.

Conducting the bomber program as a parallel to the company's production of Black Widow P-61 night fighters, mockup of the XB-35 was built, consisting of full-size crew quarters and a portion of the left wing. On July 5, 1942, the Wright Field Mockup Board approved this and the XB-35 was ready to go into detailed designing.

FOUR SIXTY-FOOTERS

To provide flight research data, four 60-foot scale models were built, designated the N9M series. The first three were powered with two Menasco engines of 275 horsepower each, so located as to duplicate as nearly as possible, the thrust lines of two of the XB-35's giant Wasp Major engines.

The first N9M was flown for several months, affording valuable information to the XB-35 engineers, as a result of about 50 flights.

This airplane was followed by a second N9M and an N9M-A and N9M-B. The latter model was powered with 300-horsepower Franklin engines, and testing continued at Muroc Army Air Base with John Myers and Harry Crosby at the controls.

The N9Ms were 60-foot scale models, slightly more than one-third the size of the XB-35 in every comparable dimension. The increase in the size to the XB-35, however, multiplied the problems of Northrop engineers.

An N9M weighs only 7,100 pounds. In increasing each dimension three times to obtain the XB-35 plan, the weight was increased to 162,000, more than 23 times the weight of the scale model.

Northrop had pioneered in the use of fully-submerged engines. But they were smaller engines. On the XB-35 it was necessary to submerge in the wing four Pratt and Whitney Wasp Majors, each developing 3,000 horsepower.

Each of these engines develops enough heat to warm a factory building. So, air ducts were built into the leading edges of the Flying Wing to supply sufficient air to keep the engines cool.

Instead of the one man who operated the N9M, the XB-35 will house nine men as its normal crew. Accommodations were built into the wing for six additional men, as alternate crew replacements on the 10,000-mile hops of which the XB-35 is capable.

Long slots run parallel to the leading edges of the Flying Wing near the tip. These slots have been thoroughly tested in the smaller Flying Wing designs. They are valuable at slow speeds. When the Flying Wing is slowed down near a stall, the slots prevent interruption of the smooth airflow, which, when disturbed, causes stalling.

Northrop engineers eyed these slots with misgivings. At slow speeds they contribute to overall operational safety, but at high speeds they present a break in the smooth "clean" surface of the all-wing airplane. They not only serve no useful purpose at high speeds, but impair the Flying Wing's efficiency.

So, Northrop engineers devised special doors which fit into these slots. These doors operate automatically. When the Flying Wing slows down to near-stalling speed the doors pop open and the slots function. At high speeds, the doors close and the smooth contour of the wing is restored.

To a man, these skilled technicians believe that the XB-35 is not only a proven and successful airplane, but an airplane of the future.

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CHARLES BRADFORD, Assistant Editor

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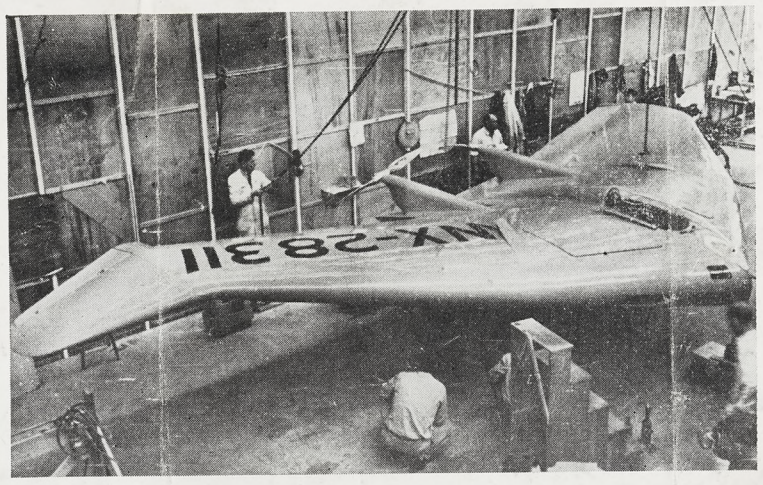
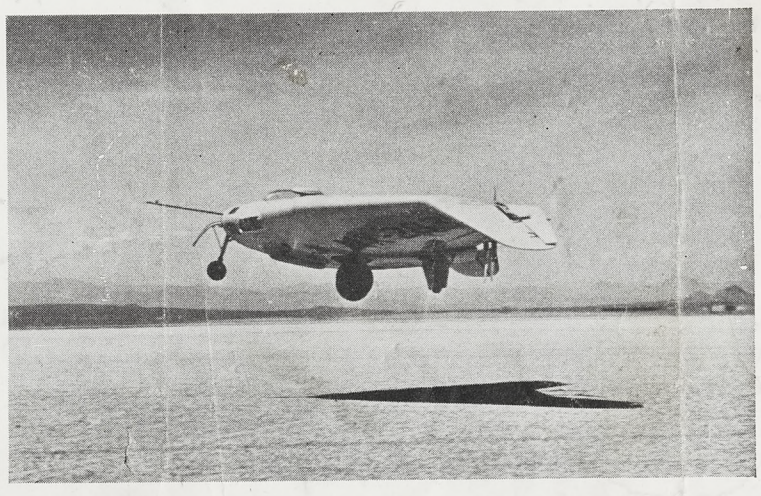
THE COVER

The cover of this special Flying Wing issue of the Northrop News is a water color by Paul Browne, Production Illustration department head. It depicts the Northrop Flying Wing XB-35 bomber in the cold blue of the stratosphere. The airplane is speeding into a climbing turn.

Art lettering layout is by Paul Trams, also of Production Illustration.



USING EXPERIMENTAL drooped wing tips, the first true Flying Wing was completed at Northrop and flew for the first time in mid-summer of 1940. This plane, later modified with straight wing tips, is now in the Wright Field Aeronautical Museum.



ONE OF THE EARLY Northrop Flying Wings was the N1M with drooped wing tips and three bladed propellers. It is shown here being tested at the Muroc Army Air Base, Muroc, California. Taxiing at high speed, it struck a rough spot, bounced and made a good flight of several hundred yards.

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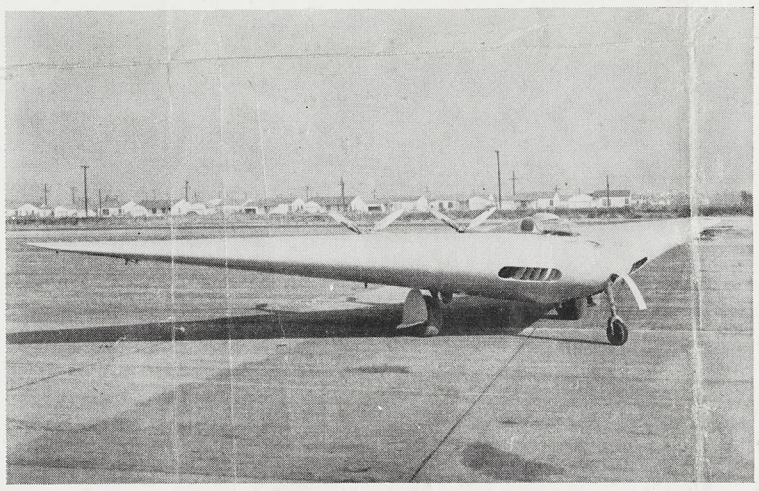
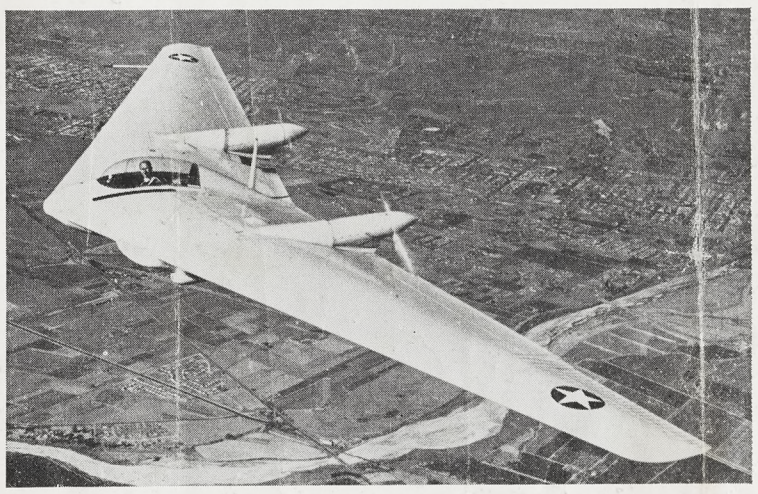
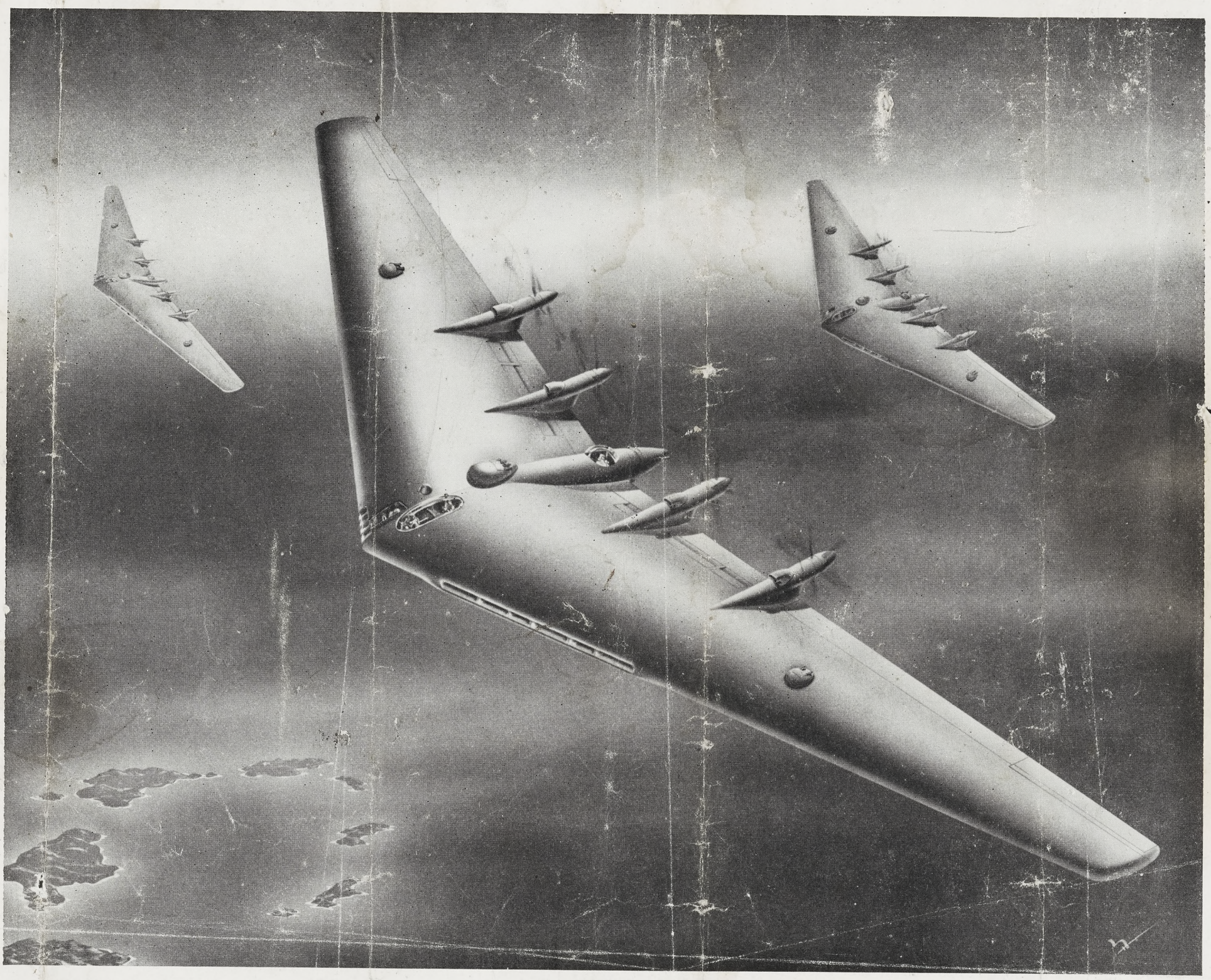


ANOTHER FORERUNNER of the Flying Wing bomber is shown here—N1M with straight wing tips. With various Northrop test pilots at the controls, this aircraft was successfully flown many times and proved to be stable and easy to control.



THE N9M, FIRST IN THE SERIES OF FOUR 60-foot scale models of the giant Northrop bomber, in flight with test pilot John Myers, now company vice president and director of sales, at the controls. Use of scale models determined flight characteristics of big Flying Wing.



THREE FLYING WING BOMBERS IN FLIGHT AS NORTHROP ARTISTS SEE THEM. PILOT SITS IN LONG BLISTER ON TOP OF WING.

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Sidelights on the Northrop Flying Wing XB-35 Bomber

Park the Northrop Flying Wing XB-35 bomber in your backyard, run its engines for an hour, and you'll have manufactured more electrical current than you use in your house during a six-week period.

The XB-35, using four alternators geared to its four Pratt and Whitney Major Wasp engines, can turn out electricity at the rate of 120 kilowatts an hour, more than enough to supply 1000 homes.

* * * * *

Ten miles of electrical wiring were used in the Northrop Flying Wing XB-35 bomber, to link its four engine-driven alternators to the lights, radio, and to dozens of electric motors which operate the gun turrets, landing gear doors, and bomb bay doors, landing gear and other equipment on the big plane.

* * * * *

Elmer, who rides with the pilot on the Flying Wing, has put on weight. He looks bigger and better than ever before.

Every Army bomber crewman knows Elmer. Elmer is the automatic pilot—a little case with a mechanical brain and muscles of hydraulic pressures and steel. He can "take over" and fly an airplane efficiently and correctly.

The XB-35's Elmer is a special, "hopped-up" version. Autopilots on conventional planes have three Servo motors, which actuate the controls and keep the plane flying straight and true. But since the all-wing XB-35 has unconventional controls, Elmer had to be changed a bit.

Engineers of the Minneapolis-Honeywell Regulator Co. designed a special Elmer for the Northrop Flying Wing. They added a fourth motor, and the resulting autopilot can fly the XB-35 just as well as the old versions can operate the conventional-type planes.

* * * * *

Elevons, the Northrop-designed combination elevators and ailerons on the Flying Wing, look small when compared with the airplane. But each elevon is more than 35 feet long—just about the size of the full wing on a Piper Cub light airplane which will carry two people.

"Big as a barn door," was the usual startled comment of visitors who took their first look at the Flying Wing's giant landing flaps, which in down position appear almost square to the slipstream, and which exert a powerful braking force in landing the 104-ton craft.

Actually the flaps are bigger than an average barn door. Each is more than 29 feet long by about six feet wide, with a total area of about 175 square feet.

* * * * *

"Plenum chambers," a unique development on the Northrop bomber, are the giant lungs which "breathe" for the big airplane and feed its 3000-plus horsepower engines with the tremendous quantities of air which they consume.

* * * * *

Split flaps, similar to those which enabled U. S. dive bomber pilots to slow down their planes and thus aim their bombs better, are used for a different purpose in the Wing.

The double split-flaps, which open like a clamshell, form the trim flaps at the trailing edge of the Wing, near the tips. When the pilot presses left rudder, the double flap opens at the left wing tip, setting up a drag which slows the wing at that end to help turn the giant plane.

Use of this flap has enabled engineers to dispense with vertical surfaces such as those used on conventional aircraft.

FACTS AND FIGURES ON THE XB-35 FLYING WING

GENERAL DESCRIPTION

All-metal, tailless, four-engine bombardment type aircraft built on the true Flying Wing design, with no tail surfaces and using elevon controls as both elevators and ailerons. Crew capacity, 15 men. Full-cantilever all metal construction. Design weight empty 89,000 pounds. Design weight, loaded, 162,000. Overload gross weight 209,000.

POWER PLANTS

Four Pratt and Whitney Major Wasps, one pair each of R-4360-17 and R-4360-21 series, equipped with single-stage General Electric turbo-superchargers. Normal horsepower, 2500 at (censored) feet; military power, 3000 at (censored) feet.

DIMENSIONS

Span, 172 feet. Root chord, 37½ feet. Tip chord, nine feet four inches. Over-all-height, 20 feet one inch. Over-all length, 53 feet, one inch.

PROPELLERS

Four, eight-bladed Hamilton Standards, superhydramatic, counter-rotating. Propeller diameter, 15 feet four inches. Reverse pitch of the propellers can be used for braking, to reduce the landing run.

LANDING GEAR GROUP

Tricycle type, with dual wheels, five feet six inches in diameter on main gear and single wheel, four feet eight inches in diameter on nose gear. Fully retractable.

CONTROLS

Northrop-designed "elevons," performing the functions of elevators and ailerons, on trailing edges of the wing. Span of each elevon, 34 feet six inches. Trim flaps and rudder assembly is at wing tip. Landing flaps occupy center section of span. Slots in wing tips aid in control at low speed. Controls actuated through full-boost hydraulic system to prevent excessive control pressures. This is coordinated with special Northrop-designed pneumatic loading devices for pilot "feel."

PURPOSE

Extreme range heavy bombardment airplane, adaptable for cargo or transport use.